# ROBOT INVENTORY UPDATES FOR ORDER ROUTING

## CROSS REFERENCE TO RELATED APPLICATION

The present application claims priority to U.S. Provisional patent application Ser. No. 62/551,181 filed on Aug. 28, 2017, the entire contents of which is incorporated herein by reference, as if fully set forth in this description.

## BACKGROUND

One or more robots and/or other actors, such as human actors, human-driven vehicles, and autonomous vehicles, can operate throughout a supply chain. The supply chain can include various regions, such as buildings, roadways, flight routes, and seaways. Some of these regions are associated with one or more spaces, such as the interior of part or all of a building and/or its surrounding outdoor regions, where robots and/or the other actors perform tasks and/or otherwise utilize the space(s) together.

An example building in a supply chain is a warehouse, which may be used for storage of goods by a variety of different types of commercial entities, including manufacturers, wholesalers, and transport businesses. Example stored goods may include raw materials, parts or components, packing materials, and finished goods. The warehouse can be visited by various vehicles, such as human-driven and/or autonomous trucks, that load and unload goods at the warehouse. In some cases, the warehouse may be equipped with loading docks to allow goods to be loaded onto and unloaded from delivery trucks or other types of vehicles. The warehouse may also use rows of pallet racks to allow for storage of pallets, flat transport structures that contain stacks of boxes or other objects. Additionally, the warehouse may use machines or vehicles for lifting and moving goods or pallets of goods, such as cranes and forklifts. Human operators may be employed in the warehouse to operate machines, vehicles, and other equipment. In some cases, one or more of the machines or vehicles may be robotic devices guided by computer control systems.

## SUMMARY

In one aspect, a method is disclosed that includes maintaining an inventory database for each warehouse of a plurality of warehouses, wherein a plurality of robots are deployed at each warehouse, wherein the inventory database for each warehouse is updated based on messages sent by the plurality of robots at the warehouse during performance of tasks by the plurality of robots at the warehouse. The method further includes receiving an order. The method additionally includes determining, for each warehouse of the plurality of warehouses, a projected availability time for an item that satisfies the order to be available for pickup at the warehouse based on the inventory database for the warehouse. The method also includes selecting a warehouse from the plurality of warehouses based on the projected availability time determined for each warehouse of the plurality of warehouses. The method further includes causing at least one robot at the selected warehouse to prepare for pickup the item that satisfies the order at the selected warehouse.

In another aspect, a non-transitory computer readable medium is disclosed having stored therein instructions executable by one or more processors to cause the one or more processors to perform functions. The functions include maintaining an inventory database for each warehouse of a plurality of warehouses, wherein a plurality of robots are deployed at each warehouse, wherein the inventory database for each warehouse is updated based on messages sent by the plurality of robots at the warehouse during performance of tasks by the plurality of robots at the warehouse. The functions further include receiving an order. The functions additionally include determining, for each warehouse of the plurality of warehouses, a projected availability time for an item that satisfies the order to be available for pickup at the warehouse based on the inventory database for the warehouse. The functions also include selecting a warehouse from the plurality of warehouses based on the projected availability time determined for each warehouse of the plurality of warehouses. The functions further include causing at least one robot at the selected warehouse to prepare for pickup the item that satisfies the order at the selected warehouse.

In a further aspect, a system is disclosed that includes a plurality of robots deployed at each of a plurality of warehouses. The system further includes a control system configured to maintain an inventory database for each warehouse of the plurality of warehouses, wherein the inventory database for each warehouse is updated based on messages sent by the plurality of robots at the warehouse during performance of tasks by the plurality of robots at the warehouse. The control system is also configured to receive an order. The control system is additionally configured to determine, for each warehouse of the plurality of warehouses, a projected availability time for an item that satisfies the order to be available for pickup at the warehouse based on the inventory database for the warehouse. The system is further configured to select a warehouse from the plurality of warehouses based on the projected availability time determined for each warehouse of the plurality of warehouses. The system is additionally configured to cause at least one robot at the selected warehouse to prepare for pickup the item that satisfies the order at the selected warehouse.

In another aspect, a system is disclosed that includes means for maintaining an inventory database for each warehouse of a plurality of warehouses, wherein a plurality of robots are deployed at each warehouse, wherein the inventory database for each warehouse is updated based on messages sent by the plurality of robots at the warehouse during performance of tasks by the plurality of robots at the warehouse. The system further includes means for receiving an order. The system additionally includes means for determining, for each warehouse of the plurality of warehouses, a projected availability time for an item that satisfies the order to be available for pickup at the warehouse based on the inventory database for the warehouse. The system also includes means for selecting a warehouse from the plurality of warehouses based on the projected availability time determined for each warehouse of the plurality of warehouses. The system further includes means for causing at least one robot at the selected warehouse to prepare for pickup the item that satisfies the order at the selected warehouse.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the figures and the following detailed description and the accompanying drawings.

## BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a diagram of a supply chain, in accordance with an example embodiment.